# Studies On Growth And Survival Rate Of Pearl Freshwater Mussel Lamellidens Marginalis During The Culture In A Pond

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***Abstract:*** *The culture of Pearl Freshwater Mussel in a pond have been studied for a period of one year (from July 2014 to June 2015) with the data on growth and survival factors and discussed with reference to similar work. During one year, the instantaneous and relative growth rate, and survival rate (%) for the pearl mussels were evaluated. A total of 864 Lamellidens marginalis were collected and the growth (shell length, width, height, weight, tissue weight and total weight) and survival of pearl mussels were measured and recorded on a monthly basis throughout the study. Average shell length, width, height, weight, tissue weight and total weight were 71.90 ± 7.04 mm,, 37.79 ± 3.69 mm, 23.31 ± 2.03 mm, 18.03 ± 6.38 g, 41.58 ± 5.13 g and 59.61 ± 11.08 g respectively. The instantaneous and relative growth rate were calculated and ranged from 0.64 % to 3.14 % and from 36.60 % to 164.45 % respectively. The minimum survival rate was registered as 94% during the month of May 2015. Water quality parameters are also tested during the initial and final culture period which in turn did not affect the growth and survival. Significant increases (P < 0.01) were detected in the shell length, height, width, weight, tissue weight and total weight of mussels at all months during the study using ANOVA.*
***Keywords:*** *Pearl freshwater mussel, Lamellidens marginalis, growth rate, survival rate, statistical analysis.*

## I. Introduction

Freshwater mussels are key components of freshwater ecosystems, and have worldwide ecological and economic significance. The freshwater bivalves are commonly found in freshwater resources like reservoirs, dam, rivers, lake and pond in India. The study, of growth and survival of the freshwater mussel , is important because it describes mathematical relationship. Change in growth is according to their habitat and life cycle [1]; Size of shell is more affected than their shape by fluctuation of environment. Many of the scientists have studied the length weight relationship in fresh water mussels [2]; [3]; [4]; [5]; [6]; [7].  Similar observation is also made and reported a non linear relationship [8]. Fresh water mussels plays a very significant role in benthic ecosystem, Tribal people consume them and also support small fishery in different parts of India. They have medicinal value and also used for pearl culture [9]; [10].

The natural aquatic resources are causing heavy and varied pollution in aquatic environment leading to pollute water quality and depletion of aquatic biota [11]. Pollution refers to undesirable changes in the physical, chemical or biological characteristics of our environment. This has adversely affected the humans and other species of our biosphere directly or indirectly [12]. Some other scientists did further  work on pearl culture from L. marginalis [13]; [14]; [15].

Lamellidens marginalis (Lamarck), an important pink pearl producing freshwater mussel is increasing demand in pearl producing countries. Placuna, Placenta, Mytilus, Hyriosis species are found abundantly in many places of the world [16]. Despite their importance, many aspects of ecology are restricted to their growth [17]; [18], ontogeny [19]; [20]; [21], species description [21]; [22], distribution [22]; [23]; [24], abundance [25] and effects of pollution [26]. Freshwater mussels are sensitive to a variety of pollutants and have a dramatic effect on the reproduction, physiology, and survival of the species [27]; [28].

Considering the importance of fresh water mussels in aquatic ecosystem present study was to evaluate the growth and survival during the period of culture.

## II. Materials And Methods

The growth and survival study were carried out from July 2014 to June 2015 in K. Sathanur, Moorthy nagar pond located in Tiruchirappalli of Tamil Nadu. Water samples were collected during the initial and final periods of study in July 2014 and June 2015 respectively for physico-chemical analyses in sterile bottles and taken to the laboratory aseptically. The collection was usually completed during morning hours between 6:00 a.m. to 10:00 a.m. For each sampling event, odour (Odo), turbidity (Tur), temperature (Tem), pH and dissolved oxygen (DO) were monitored at the sampling sites while total dissolved     solids (TDS), salinity (Sali.), total hardness (TH), calcium (Ca), magnesium (Mg), sodium (Na) and potassium  (K) were analyzed in the laboratory in accordance with the methods of APHA (1998) [29].

Fresh water bivalves Lamellidens marginalis samples (n=72) with length ranged from 60 mm to 90 mm and weight ranged from 35 g to 90 g were collected from Koraiyar River of Tiruchirappalli, Tamil Nadu between July 2014 to June 2015. These mussels were collected by hand from different depths ranging from 5-10 cm. The mussels were kept in a container along with pond water and transferred to the laboratory for acclimatization for five days with pond water for conditioning.. The average water depth of the pond varied from 1-2 meter. The bottom mud of the pond was silty and muddy with a depth ranged from 10-20 cm. Samples were usually collected from sediment's surface of the river. Overall, 864 samples were collected. Samples were transferred alive to laboratory after washing with river water.

Initially length, width and height were measured to the nearest 0.01 millimeter (mm) and shell weight, tissue weight and total weight were weighed to the nearest 0.01 gram (g) by using Vernier Callipers and Cyberlab-US Sereis portable monopan electronic digital balance respectively. Prior to weigh the Mussel the adductor muscles were cut by using scalpel through the valves. Afterward, the water inside was removed and various weights were taken individually.
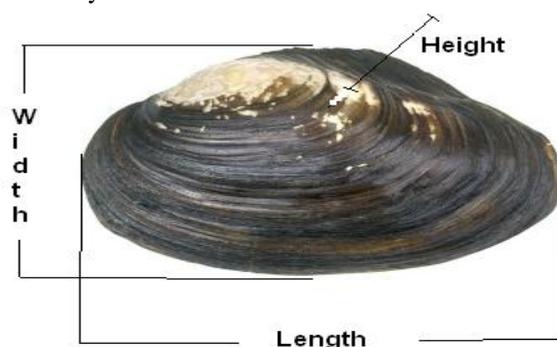


Fig. 1: Morphological measurements of the shell in Lamellidens marginalis.

Length was measured from maximum antero- posterior distance, width was measured from top hinge joint to lower shell edge distance and height was measured from dorso-ventral distance as shown in Figure 1. The cages of 40 cm length x 40 cm width x 20 cm height were made of steel frames with nylon net. The cages were closed on all sides by net except the top. Cages were placed in the culture pond at a water depth of 1meter. Twelve mussels were kept in each cage with six replications. Mortality rate were recorded at every month of intervals. Mussels were finally harvested from the cages at the end of each month of the culture period and measured in the spot itself and the data were recorded and tabulated.

The instantaneous growth rate (K) for length, width, height and weight, was calculated by modifying the following equation for each measurement [30]: $K = (\ln W_2 - \ln W_1)/t$, where $W_1$, $W_2$ are respective size measurements (shell length, shell width, shell height, shell weight, tissue weight, or total weight) at the beginning and end of the study, respectively. The duration of the study (in months) is expressed by t.

Relative growth rate (RGR %) was calculated: $(W_2-W_1/W_1) \times 100$ where $W_2$ and $W_1$ is the final and initial weight, respectively.

To determine the survival rate of mussels, every individual of each cage was counted for the number of alive mussel. Any mussel having its valve open or having the smell of decomposition was treated as a dead one. On the following sampling date every alive individual in each cage was again counted for the number of alive mussel in the same way. Sampling was done at every month of intervals. The survival rate of each cage in each sampling was expressed in percentage and was calculated using the following formula:
S = n/ N x 100

Where, S is the survival rate (%) for each sampling, n is the number survived for each sampling, N is the initial number stocking. Finally, at the close of the experiment, the entire stock of mussels of each cage was collected and survival rates (%) were computed from the initial and final data.

Differences in mean size of the mussels along with standard deviation (length, width, height and weight) between the beginning and end of the culture period were tested by using a one-way ANOVA [31]. $P < 0.05$ was accepted as the level of significance for all analyses.

## III. Results

The Physico-chemical data of the pond water situated at K. sathanur during the initial and final periods of study in July 2014 and June 2015 for 13 physico-chemical parameters are presented in Table-1.

The water samples of pond are colourless and also with no objectionable odour. The turbidity of water samples ranged between 3.6 – 3.9 NTU for pond water.]. The temperature was ranging from 28°C to 29.80°C during the study period in pond water. pH of the pond water was initially 7.3 but during the final period it was

7.9. Dissolved Oxygen in this study ranges from 5.7 mg/l to 6.1 mg/l. Total dissolved solids was recorded between 29.5 and 31.5 mg/l. The salinity, alkalinity and hardness were registered between 270.8 mg/l and 291.4 mg/l, 525 mg/l and 580 mg/l, and, 255 mg/l and 297 mg/l respectively. Further, the concentration of calcium (from 65.6 mg/l to 70.6 mg/l), magnesium (from 88.4 mg/l to 99.8 mg/l), sodium (from 42.5 mg/l to 47.3 mg/l) and potassium (from 5.7 mg/l to 6.2 mg/l) were estimated (Table 1).

**Table 1: Physico-chemical characteristics of pond water in the initial (July 2014) and final (June 2015) periods of pearl freshwater mussel culture.**

| Period | Odo | TurN TU | Tem ºC | pH | DO mg/l | TDS mg/l | Sali. mg/l | TA mg/l | TH mg/l | Ca mg/l | Mg mg/l | Na mg/l | K mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| July'14 | U | 3.9 | 28 | 7.3 | 6.1 | 315 | 291.4 | 580 | 297 | 65.6 | 88.4 | 42.5 | 6.2 |
| Jun'15 | U | 3.6 | 29 | 7.9 | 5.7 | 295 | 270.8 | 525 | 255 | 70.6 | 99.8 | 47.3 | 5.7 |

Ca – Calcium; DO – Dissolved Oxygen; K – Potassium; Mg – Magnesium; Na – Sodium; Odo – Odour; pH – Hydrogen Ion Concentration; Sali. – Salinity; TA – Total Alkalinity; TDS – Total Dissolved Solids; Tem – Temperature; TH – Total Hardness; Tur – Turbidity.
ºC – Degree Centigrade; mg/l – milligram per liter; NTU – National Turbidity Unit; U - Unobjectionable.

100 % Survival rates in the culture of mussels at the pond were registered in the months of July 2014 to October 2014 and from January 2015 to March 2015. But during the months of November and December 2014 the survival rates were 97% and 99% respectively and during the months of April, May and June 2015 the survival rates were 97%, 94% and 96% by the end of the study (Table 2). There were no statistical differences among the study, although mussels in the month of May 2015 had the mortality of four mussels.

**Table 2: Survival Rate of Lamellidens marginalis during the culture period.**

| Number of alive mussels | Year and Month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2014 | | | | | | 2015 | | | | | |
| | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
| Initial | 72 | 72 | 72 | 72 | 72 | 72 | 72 | 72 | 72 | 72 | 72 | 72 |
| Final | 72 | 72 | 72 | 72 | 70 | 71 | 72 | 72 | 72 | 70 | 68 | 69 |
| Survival Rate (%) | 100 | 100 | 100 | 100 | 97 | 99 | 100 | 100 | 100 | 97 | 94 | 96 |

The descriptive statistic includes, mean, standard deviation, shell length, shell width, shell height, shell weight, tissue weight and total weight. Data collected from 864 specimens were used to determine the instantaneous and relative growth rates with initial and final values including shell size (length, width, height) and weight (shell, tissue and total) (Tables 3). Significant increases ($P < 0.01$) were detected for the relationship between the shell length, height, width, weight, tissue weight and total weight of mussels at all months during the study using ANOVA.

**Table 3: Growth in Shell Length, Width, Height, Weight, Tissue weight and Total Weight\* of Lamellidens marginalis during the culture period from July 2014 to June 2015.**

| Period of culture | Parameters | | | | | |
|---|---|---|---|---|---|---|
| | Shell Length (mm) | Shell Width (mm) | Shell Height (mm) | Shell Weight (g) | Tissue Weight (g) | Total Weight (g) |
| July 2014 | 62.45±0.96 | 33.48±0.41 | 21.01±0.64 | 11.90±1.13 | 30.84±2.78 | 42.75±3.65 |
| August 2014 | 64.85±1.87 | 34.26±1.08 | 21.78±0.95 | 11.13±1.94 | 34.29±3.12 | 45.42±4.99 |
| September2014 | 65.78±1.65 | 35.18±1.49 | 21.73±0.81 | 13.38±2.00 | 38.04±3.64 | 51.43±5.61 |
| October 2014 | 66.26±1.77 | 34.73±1.15 | 21.95±0.91 | 12.65±2.37 | 39.34±4.91 | 51.99±7.25 |
| November 2014 | 68.68±1.21 | 35.88±0.73 | 22.48±0.58 | 13.92±2.12 | 40.96±4.59 | 54.84±6.74 |
| December 2014 | 68.53±2.25 | 36.45±0.49 | 22.46±1.03 | 13.74±1.58 | 40.67±2.05 | 54.41±3.59 |
| January 2015 | 70.10±1.46 | 37.58±2.13 | 23.81±0.68 | 16.80±2.61 | 43.86±2.41 | 60.66±5.02 |
| February 2015 | 72.91±1.72 | 37.78±2.36 | 23.45±1.31 | 18.54±2.12 | 44.35±2.16 | 62.89±4.22 |
| March 2015 | 76.70±3.24 | 40.18±1.99 | 25.25±1.67 | 21.90±3.02 | 44.16±1.70 | 66.07±3.73 |
| April 2015 | 79.10±1.64 | 38.86±1.58 | 22.33±0.99 | 23.47±2.19 | 47.39±1.12 | 70.86±2.50 |
| May 2015 | 82.00±1.68 | 42.06±1.43 | 24.83±1.83 | 27.56±2.53 | 46.01±3.73 | 73.57±6.22 |
| June 2015 | 85.46±2.48 | 47.08±3.37 | 28.70±2.20 | 31.47±2.60 | 49.06±2.25 | 80.54±4.66 |
| Mean ± SD\*\* | 71.90±7.04 | 37.79±3.69 | 23.31±2.03 | 18.03±6.38 | 41.58±5.13 | 59.61±11.08 |

Each value represents *Mean ± SD of six determinations and **Mean ± SD of twelve determinations.

In all cases, the calculated values were more than the values of 'F' table. The shell length, height, width, weight, tissue weight and total weight of mussels at all months during the study were recorded initially as 62.45 mm, 33.48 mm, 21.01 mm, 11.90 g, 30.84 g and 42.75 g and finally as 85.46 mm, 47.08 mm, 28.70 mm, 31.47 g, 49.06 g and 80.54 g respectively. The differences between final and initial data were recorded as 23.01 mm, 13.60 mm, 07.69 mm, 19.57 g, 18.21 g and 37.79 g respectively for the shell length, height, width, weight, tissue weight and total eight of mussels (Table 3). These data were used to determine the instantaneous as well as relative growth of the mussels during the period of study (Table 4).

**Table 4 : Instantaneous and Relative Growth Rate for Shell Length, Width, Height, Weight, Tissue weight and Total Weight\* of Lamellidens marginalis during the culture period.**

| Period of culture | Parameters | | | | | |
|---|---|---|---|---|---|---|
| | Shell Length (mm) | Shell Width (mm) | Shell Height (mm) | Shell Weight (g) | Tissue Weight (g) | Total Weight (g) |
| Final Value ($W_2$) | 85.46 | 47.08 | 28.70 | 31.47 | 49.06 | 80.54 |
| Initial Value ($W_1$) | 62.45 | 33.48 | 21.01 | 11.90 | 30.84 | 42.75 |
| Difference ($W_2$-$W_1$) | 23.01 | 13.60 | 07.69 | 19.57 | 18.21 | 37.79 |
| Total Months (t) | 12 | 12 | 12 | 12 | 12 | 12 |
| Instantaneous Growth Rate % = Difference/Month | 23.01/12 1.91% | 13.60/12 1.13% | 07.69/12 0.64% | 19.57/12 1.63% | 18.21/12 1.51% | 37.79/12 3.14% |
| Relative Growth Rate = $\frac{W_2-W_1}{W_1}$ x 100 | 23.01/62.45= 0.3684X100 = 36.84% | 13.60/33.48= 0.4062X100 = 40.62% | 07.69/21.01= 0.3660X100 = 36.60% | 19.57/11.90= 1.6445X100 = 164.45% | 18.21/30.85= 0.5902X100 = 59.02% | 37.79/42.75 = 0.8839X100 = 88.39% |

## IV. Discussion

The obtained results of physic-chemical parameters were compared with Standard prescribed under APHA [29]. The colourless water of pond has unobjectionable odour. Temperature is an important biologically significant factor, which plays an important role in the metabolic activities of the organism. It also influences the metabolic behavior of aquatic ecosystem [32]; [33]. pH is a term used universally to express the intensity of the acid or alkaline condition of a solution. Most of the water samples are slightly alkaline due to presence of carbonates and bicarbonates. pH of bore water influenced by geology of catchment area and the buffering capacity of water. The pH variation is mostly due to diurnal interplay of photosynthesis and community respiration of the biota and also is one of the most important single factors, which influences aquatic production [34]. The pond water values were more than 7.0 and impart the alkaline condition.

Dissolved Oxygen in water is essential for life. Deficiency of dissolved oxygen gives bad odour to water due to anaerobic decomposition of organic waste [35]. Dissolved Oxygen in this study ranges from 5.7 mg/l to 6.1 mg/l in pond water. In any aquatic ecosystem the level of dissolved oxygen depends on the factors like temperature of water, concentration of dissolved solids and biological activity of all life. Total dissolved solids denote mainly the various kinds of minerals available in the water. In natural waters dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, sulfates, phosphates, nitrate, calcium, magnesium, sodium, potassium and iron [36]. In the present investigation maximum value of total dissolved solids was recorded as 315 mg/l in July 2014 and minimum value of 295 mg/l was observed in June 2015.

The chloride concentration or salinity serves as an indicator of pollution by sewage. People accustomed to higher chloride in water are subjected to laxative effects [37]. In the present analysis, chloride concentration was found in the range of 270.8 mg/l to 291.4 mg/l. This again implies that all the waters studied were all of satisfactory quality in terms of their chloride contents and that chloride does not contribute to problems of taste in some of the waters [38]; [39]. Alkalinity of water is its capacity to neutralize a strong acid and it is normally due to the presence of bicarbonate, carbonate and hydroxide compound of calcium, sodium and potassium [40]. Total alkalinity were recorded at the standard range between 525 mg/l to 580 mg/l.

Hardness is the property of water which prevents the lather formation with soap and increases the boiling points of water. Hardness of water mainly depends upon the amount of calcium or magnesium salts or both [40]. Calcium is a soft gray alkaline earth metal which is directly related to hardness. Calcium is the most abundant substances of the natural water. In aquatic environment calcium serves as one of the micronutrients for most of the organisms [41]. Magnesium is one of the most abundant elements in nature and it is a significant member in water hardness, it gives an unpleasant taste to water. Magnesium is essential for chlorophyll bearing

organism, since it goes into composition of the pigments. Decrease value of magnesium may be due to plankton and algal uptake [39]. Sodium and Potassium play a vital role in osmoregulation and metabolism of aquatic animal environment respectively and the later is an important macronutrient [41]; [42].

Size and weight are two basic components in the biology of species at the individual and population levels. Information on size and weight measurement is essential for proper assessment and management of these fisheries [43]. The size–weight data are also employed in physiological investigations, and to obtain estimates of seasonal variation in growth or productivity [44]. The purpose of this research is to investigate the morphometric measurement of shell length, width, height, weight, tissue weight and total weight.

The studies which examine size-weight relationship in L. marginalis found that a variety of environmental factors are known to influence shell morphology and the relative proportions. Similarly, in a study Satit Kovitvadhi et al. (2008) [45] studied weight and size relationship of cultured freshwater pearl mussel. Their results showed that significant differences in the mussel shell size– weight ratio (P < 0.01). Our results reveal significant differences in shell size and weight increases. Bivalve shell growth and shape are influenced by biotic (endogenous/ physiological) and abiotic (exogenous/environmental) factors [46]. For examples, the type and quality of phytoplankton as a food source of the mussels [47], water quality [48], water depth [49], currents [50], water turbulence [51], type of sediment [48], type of bottom [49] and wave exposure [52]. In the present study, sampling performed from pond bottom with soft sediments in all parts. Therefore a suitable biological condition is provided for L. marginalis. The results from the current study lead to two insights into the application of morphometric data. Firstly, measurements of shell length rather than shell height were consistently proportional to the weight during culture period. Secondly, the application of the morphometric relationship between the shell height and weight is the most useful relation for stock assessment and management of L. marginalis in pond environment.

Factors contributing to the success of Dreissena rostriformis bugensis could include differences in long-term growth and survival, throughout different seasons, the reproductive capacity of the two Dreissena species, or characteristics of the veligers [53]; [54]; [55]. A deep water (profunda) form of D. rostriformis bugensis occurs in Russia [56]; [57] and in the Great Lakes of North America [58]. In our experiment we used D. rostriformis bugensis mussels collected from the littoral zone of a Dutch lake and a river canal so mussels were not likely the deep water morph. Mytilopsis leucophaeatais characteristically a brackish water species, but has been reported to tolerate freshwater conditions for relatively long periods [59].

The results of this study indicated that development and maturation of mussel is important for successful culture and that optimization of the culture environment is critical. When culture technology is optimized to promote good survival and growth of mussels, the majority of mortality related to the culture environment will probably begin later, at about 9–12 months of culture period.

From the results of the physico-chemical parameters the K. Sathanur pond is a non-polluted freshwater body with more nutrients which make the water fit enough for the survival of aquatic organisms. The results obtained from the present investigation of pond fresh water shall be useful in culturing the Freshwater Mussel, L. marginalis.

## V. Conclusion

In this study, it has been shown that growth and survival of L. marginalis may be significantly impaired by 12 months exposure in 1meter depth of K. Sathanur pond. The assessment of water quality is an important factor for the growth and survival of the mussel in a better way. This study revealed that the water in the studied area is suitable for drinking and domestic purposes including the cultural performance of aquatic organisms at the physic-chemical level. The results were compared favourably with standards. The findings of the present study confirmed that L. marginalis records growth and survival similar to other related pearl producing species.

## Acknowledgement

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